We have utilized our recently developed method to characterize lipid areas of various phospholipids with varying numbers of carbons and double bonds. In the case of lipids with unsaturated fatty acid chains our results suggest that lipid areas change with increasing hydrocarbon chain length, but not linearly - lateral lipid area is the result of the fine balance between the hydrocarbon chain length and double bond position. Furthermore, we discovered that the most dramatic change in lipid area occurs after the introduction of the first double bond to the lipid's acyl chains.
Besides their importance in biology, lipid areas play a central role in molecular dynamics (MD) simulations, where their inconsistencies have been highlighted by the disparate results arising from MD simulations using different force fields. Since MD force fields are considered to be "well tuned" if they are able to reproduce experimental data, more reliable experimental information is necessary for their future development.

3388-Pos Board B493
Cardiolipin, a Key Component to Mimic the E. coli Bacterial Membrane in Model System Membranes
Sílvia Lopes, Cristina Neves, Peter Eaton, Paula Gameiro.
The phase transition temperatures of several lipidic systems were determined using two different techniques: dynamic light scattering (DLS) and steady-state fluorescence anisotropy, using two fluorescent probes that report different membrane regions (TMA DPH and DPH). Atomic force microscopy (AFM) was used as a complementary technique to characterize different lipid model systems under study. The systems were chosen due to the increased interest in bacterial membrane studies due to the problem of antibiotic drug resistance. The simpler models studied comprised of mixtures of POPE and POPG lipids, which form a commonly used model system for E. coli membranes. Given the important role of cardiolipin (CL) in natural membranes, a ternary model system, POPE/POPG/CL, was then considered. The results obtained in these mimetic systems were compared to those obtained for the natural systems E. coli polar and total lipid extract. DLS and fluorescence anisotropy are not commonly used to study lipid phase transitions, but it was shown that they can give useful information about the thermotropic behaviors of model systems for bacterial membranes. These two techniques provided very similar results, validating their use as methods to measure phase transitions in lipid model systems. The temperature transitions obtained from these two very different techniques and the AFM results clearly show that cardiolipin is a fundamental component to mimic bacteria membranes. The results suggest that the less commonly used ternary system is a considerably better mimic for natural E. coli membranes than binary lipid mixture.

3389-Pos Board B494
Bioenergetics Explains the Structures of Membrane Lipids: Cholesterol, Plant Sterols, Unusual Fatty Acid Chains and Polyisoprenes
Thomas H. Haines.
All living membranes support cation gradients, which they maintain by cation pumps: proton pumps or – for the animal plasma membrane – sodium pumps. This includes the organelle membranes of the eukaryote. The negative side of the gradient faces the cells' cytoplasm. Lipid bilayers leak both H+ and Na+ at rates that are equivalent in vivo (H+ is ~10-5 cm/sec without a membrane potential([H+] is ~10-7) whereas Na+ is ~10-12 cm/sec without a membrane potential ([Na+] is ~10-1). The resident membrane potential increases the rate of leakage. Cation leakage requires the cell to spend ATP energy pumping the cations back out. Resting cells spend 70 to 80% of their ATP on cation pumping. Cholesterol, found in animals, is the only lipid tested that inhibits Na+ leakage across phospholipid bilayers. It decreases leakage to 1/3 membranes w/o it. Meanwhile many membrane lipid structures inhibit H+ leakage by: 1) decreasing water diffusion through bilayers; 2) thickening the bilayer; 3) packing the bilayer cleavage with hydrocarbon.
1) sterols, hopanoids, tetrahymenol decrease membrane water permeability. 2) polyisoprenes, CoQ, squalene, dolichol, vitamin E., and carotenes thicken the membrane bilayer. 3) Iso- and anteiso-fatty acids, branched plant sterols, and chains in extreme acidophiles terminating with cyclohexane or cycloheptane groups.
A unique phospholipid, cardiolipin (CL), displays a high pK2 (~8.0) in bilayers. This appears to facilitate ATP synthesis in membranes that use the F0F¬1ATPase to make ATP. Except for the chloroplast with its CF0CF¬1ATPase, CL always accompanies the F0F¬1ATPase.
In sum, membrane lipid structures are uniquely designed to support membrane bioenergetics. This makes the structures of membrane lipids as biochemically functional as are the structures of amino acids, nucleotides and carbohydrates are for proteins, nucleic acids and CHO polymers.

3390-Pos Board B495
Material Properties of Matrix Lipids Determine Conformation and Intermolecular Reactivity of a Diacetylenic Phosphatidylcholine in the Lipid Bilayer
Anu Puri, Hyunbum Jang, Amichai Yavlovich, Alex Haber,
Athar M. Masood, Timothy D. Veenstra, Ulrich Baxa, Ruth Nussinov,
Robert Blumenthal.
Photopolymerizable phospholipid $DC_{8,9}PC$ (1,2-bis-(tricosa-10,12-diynoyl)-*sn*-glycero-3-phosphocholine) exhibits unique assembly characteristics in the lipid bilayer. Due to the presence of the diacetylene groups, $DC_{8,9}PC$ undergoes polymerization upon UV (254 nm) exposure and assumes chromogenic properties. Photopolymerization in a gel phase lipid matrix (DPPC) monitored by UV-VIS absorption spectroscopy occurred within 2 minutes after UV treatment, whereas no spectral shifts were observed when $DC_{8,9}PC$ was incorporated in a liquid phase matrix (POPC). Calcein release from DPPC/$DC_{8,9}PC$ liposomes was observed after a lag of 10 minutes following UV triggering, whereas no release occurred from POPC/$DC_{8,9}PC$ liposomes. LC-MS analysis showed a decrease in $DC_{8,9}PC$ monomer without any change in DPPC concentration in UV-treated samples. Cryo-electron microscopy revealed fiber-like structures in the UV-treated DPPC/$DC_{8,9}PC$ liposomes with few intact vesicles remaining indicating that the leakage of calcein was due to the disruption of liposomes. Molecular Dynamics (MD) simulations of DPPC/$DC_{8,9}PC$ bilayer indicate that lipid tails in the gel phase are more highly ordered than in the fluid phase of POPC/$DC_{8,9}PC$ bilayer, packing each other into close proximity. We speculate that well-packed fatty acyl chains can increase the probability of light-induced polymerization in $DC_{8,9}PC$. Further, MD simulations suggest that motions of $DC_{8,9}PC$ in the gel phase bilayer are more restricted than in the fluid bilayer. The restricted motional flexibility of $DC_{8,9}PC$ enables the reactive acetylenes in individual molecules to align and undergo the polymerization reaction, whereas the unrestricted motions in the fluid bilayer lead to a dampening of UV-triggered polymerization due to the lack of appropriate alignment of the fatty acyl chains. These studies may have implications for physicochemical effects at the nanoscale that may occur in biological membranes as a result of signaling, transport, and fusion.

3391-Pos Board B496
SANS Investigation of the Response of DMPC-DMPG Lipid Bilayers to Membrane-Active Peptides
Shuo Qian, William T. Heller.
Membrane-active peptides disrupt the integrity of cell membranes and form transmembrane pores in model lipid bilayers. Alamethicin and melittin are two extremely well-characterized examples of membrane-active peptides that are known to undergo a concentration-dependent transition from a surface-adsorbed state to a state in which transmembrane pores are formed, resulting in the death of the target cell. The action of these peptides strongly depends on the composition of the lipid bilayer membrane. In particular, charged lipids and cholesterol are thought to drive the cellular specificity of the cytotoxicity of these membrane active peptides. Further, lipid rafts, enriched domains in multi-component membranes, can concentrate or exclude proteins and peptides associated with lipid bilayers. SANS with contrast variation was used to probe the response of small-unilamellar vesicles (SUVs) composed of mixtures of the neutral lipid DMPC with the charged lipid DMPG to the presence of alamethicin and melittin. SUVs made of chain-deuterated d54-DMPC and DMPG at a molar ratio of 7: 3 were studied in the absence and presence of the two peptides in H2O/D2O mixtures containing 90% D2O solution. The measurements in 90% D2O, which is at the match point of the readily available d54-DMPC, greatly enhances the scattering from the hydrogenated components and ensure maximum signal for any in-bilayer aggregates or an asymmetric distribution between the leaflets of the bilayer of hydrogenated material that may form. The SANS experiments were performed using the BIO-SANS of HFIR at ORNL, which provided excellent signal for the dilute SUVs solutions. We found in both alamethicin and melittin, the asymmetric distribution of two lipids between the two monolayers increases with the peptide concentration. Interestingly, melittin was found to produce a stronger effect than alamethicin.

3392-Pos Board B497
Inclusion of Menaquinone in Lipid Membranes Decreases Susceptibility to Antimicrobial Peptides
Julia Nepper.
Most studies on the interaction of antimicrobial peptides with lipid bilayers have used unsaturated, fluid-state phospholipids to model bacterial membranes. However, unsaturated lipids are rarely found in cell membranes of gram-(+) bacteria, including *Staphylococcus aureus*. To maintain cell membrane